July 1964

U.S. FOREST SERVICE
RESEARCH NOTE RM - 24

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Soil Water Storage Under Natural and Cleared Stands of Alligator and Utah Juniper in Northern Arizona

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Will clearing juniper appreciably affect soil water storage? This question was investigated on Beaver Creek Watershed on Arizona's Mogollon Rim. Here, clearing operations have been underway since 1957 for purposes of improving forage and water yields.

This area experiences two distinct "wet" periods--a summer period from about July to September, and a winter period from about December to April. Emphasis was given to sampling at the beginning and ending of "wet" periods, or over the widest range of soil water storage. Emphasis was also given to warmer months or "growing season" when soil water differences between cleared and natural areas presumably would be more pronounced.

Soil water measurements were restricted to percent water by weight in the upper 2 feet of soil, a Springerville clay to clay loam. For quantitative comparisons, a difference of 1 percent by weight over the upper 2 feet of soil is approximately equal to a layer of water three-tenths of an inch deep.[2]

Ten pairs of 50-foot-square plots were located at 1/2- to 3-mile intervals along and 100 yards away from boundaries of areas recently cleared of juniper. Five pairs were in the Utah juniper (Juniperus osteosperma (Torr.) Little) type and five pairs in the alligator juniper (J. deppeana Steud.) type. A pair consisted of plots located 50 to 100 yards on either side of a clearing boundary (aspect, slope, and slope position being similar). Plots of a pair were then matched for number and height of trees, soil depth, and soil type (table 1). In the clearing operation, trees are left on the ground; this makes it possible to determine tree number and height for cleared plots.

A Veihmeyer tube was used to obtain four randomly located samples from each plot on each of nine dates. Cores were weighed, ovendried at 104° C. for 48 hours, and reweighed. Percent moisture was calculated by dividing weight lost by ovendried weight.

To better interpret results, measurements of ground cover (table 1) and precipitation (table 2) were also obtained.

[1] *Research Forester, Rocky Mountain Forest and Range Experiment Station with central headquarters maintained at Fort Collins, in cooperation with Colorado State University.*

[2] *Skau, C. M. Some hydrologic characteristics in the Utah juniper type of northern Arizona. 1960. Unpublished Ph.D. thesis on file at Mich. State Univ., East Lansing.*

RESULTS AND DISCUSSION

Table 2 summarizes results of 90 comparisons: 9 dates times 10 plot pairs. More water was stored on cleared plots for 75 of the 90 comparisons. Differences were small, however, ranging from -6.6 to +8.7 percent, with only 15 exceeding ±4.0 percent. The overall average difference between cleared and natural plots was 1.1 percent for alligator juniper and 2.5 percent for Utah juniper--less, in either case, than a layer of water 1.0 inch deep.

Interestingly, the differences between cleared and natural plots were not particularly related to the level of soil water; twice in late June, for example, near the end of droughtlike weather, there was an average difference of about 2 percent. Similarly, on April 4, 1960, following considerably above-average winter precipitation, the average difference was well within the sampling error.

Differences in stored water were not pronounced in the "growing season" or warmer months. One explanation is provided in table 1: in September, cleared plots supported one to nine times as much ground cover as natural plots. Perhaps these volunteer species keep soil water at the same level found in natural areas.

From a practical point of view, the investigations indicate that: (1) clearing may considerably increase water available for forage production, and (2) clearing will have little effect on water yields insofar as they are influenced by soil water storage in the upper 24 inches. Not only is there little difference in stored water between cleared and natural areas, but much storage capacity remains unused year-round. These soils have a water storage capacity of about 3 to 3-1/2 inches of water per foot of soil in the range between near wilting point and saturation.[2] The corresponding range in percent water by weight is from about 17 at the wilting point to 37 percent at saturation. The highest value measured from one plot was about 29 percent on April 4, 1960, following considerably above-average winter precipitation. Unused storage capacity would be about 2.70 inches.

Finally, it should be emphasized that the conclusions are conditioned by: (1) the limited number of sites and dates used, (2) the fact that all soils were at least 2 feet deep, and (3) the assumption of matching paired plots.

Table 1.--Comparison of data from paired plots in cleared (C) and natural (N) stands of two juniper species on two types of soil, Springerville clay (C) and Springerville clay loam (CL)

Species and plot pairs		Number of trees		Average height		Average ground cover[1]		Average soil depth[2]		Soil type	
		C	N	C	N	C	N	C	N	C	N
				Ft.		Lbs./acre		Ft.			
Alligator juniper:	1	5	4	9	11	82	48	2.3	2.9	C	C
	2	4	8	10	10	87	37	2.0	2.0	C	C
	3	11	8	11	10	55	44	2.8	3.0	C	C
	4	9	7	12	13	99	16	3.5	4.0	CL	CL
	5	10	9	12	10	72	39	2.7	3.2	CL	CL
Utah juniper:	1	6	4	9	10	90	48	2.3	2.3	C	C
	2	1	1	14	14	118	13	2.0	2.1	C	C
	3	5	9	17	15	37	6	2.8	3.1	C	C
	4	1	5	15	10	62	44	2.8	3.5	C	C
	5	5	6	10	12	24	24	3.2	3.0	C	C

[1] As of September 1959, based on 5 milacre subplots; vegetation clipped and dried at 67°F.
[2] Based on 5 random samples per plot.

Table 2. --Comparisons of average soil moisture in the upper 2 feet for five cleared[1] and five natural[1] plots in each of two juniper types on nine sampling dates, 1959-60

Date		Average soil moisture			Average precipitation between sampling dates
		Cleared	Natural	Difference	
		- - - - Percent - - - -			Inches
		ALLIGATOR JUNIPER			
1959:	June 30	19.0	17.0	2.0	--
	July 25	21.0	19.4	1.6	0.98
	August 3	19.0	18.1	.9	1.64
	September 4	20.5	19.6	.9	3.12
1960:	April 4	27.8	29.2	-1.4	15.04
	May 12	27.0	25.1	1.9	1.64
	June 29	19.3	17.4	1.9	.35
	September 14	25.5	24.7	.8	6.84
	December 1	24.2	22.6	1.6	2.90
	Average			1.1	
		UTAH JUNIPER			
1959:	June 30	18.6	16.3	2.3	--
	July 25	23.0	18.9	4.1	1.23
	August 3	19.2	17.7	1.5	1.11
	September 4	21.6	19.8	1.8	3.42
1960:	April 4	27.7	26.1	1.6	12.72
	May 12	26.6	22.1	4.5	1.52
	June 29	18.0	16.2	1.8	0
	September 14	21.3	19.2	2.1	4.16
	December 1	21.7	18.9	2.8	2.75
	Average			2.5	

[1] Average of twenty 2-foot-deep samples; i.e., four random samples per plot for five plots.